DOCUMENT RESUME

ED 278 684 TM 870 101

AUTHOR Marsh, Herbert W.
TITLE Causal Effects of Academic Self-Concept on Academic Achievement: A Reanalysis of Newman (1984).
PUB DATE [86]
NOTE 11p.
PUB TYPE Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Attribution Theory; Correlation; Effect Size; Elementary Secondary Education; Estimation (Mathematics); *Factor Analysis; *Factor Structure; Influences; Item Analysis; Longitudinal Studies; *Mathematical Models; *Mathematics Achievement; Path Analysis; Research Problems; *Self Concept
IDENTIFIERS *Indicators; LISREL Computer Program; *Newman (R S)

ABSTRACT

Newman (1984) examined the causal relations between math self-concept and math achievement in an 8-year longitudinal study using Linear Structural Relations (LISREL) analyses. He concluded that math self-concept did not influence subsequent math achievement. However, the study suffered in that math self-concept was inferred from a single-item scale. Newman addressed this problem, proposed a reasonable solution to it, and based his findings on this solution. However, an alternative solution used in the present reanalysis of his data did support the causal influence of self-concept on subsequent achievement. The purpose of this investigation is to demonstrate the problems associated with single-item indicators in LISREL analyses. The study refutes Newman's conclusion that self-concept has no causal influence on subsequent academic achievement, and argues that it is necessary for such studies to have at least two or more indicators for each latent construct. (Author/JAZ)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

Causal Effects of Academic Self-concept on Academic Achievement: A Reanalysis of Newman (1984)

Herbert W. Marsh
University of Sydney, Australia

ED278684

Running Head: Causal Effects of Self-Concept

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

H. Marsh

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

TM 870 101

BEST COPY AVAILABLE

Causal Effects of Academic Self-concept on Academic Achievement:
A Reanalysis of Newman (1984)

Abstract

Newman (1984) examined the causal relations between math self-concept and math achievement in an eight-year longitudinal study using powerful LISREL analyses. He concluded that math self-concept did not influence subsequent math achievement. However, the study suffered in that math self-concept was inferred from a single-item scale. Newman addressed this problem, proposed a reasonable solution to it, and based his findings on this solution. However, an alternative -- perhaps equally plausible -- solution used in the present reanalysis of his data did support the causal influence of self-concept on subsequent achievement. The purpose of this investigation is not to argue or against either solution, but to demonstrate the problems associated with single-item indicators in LISREL analyses. Nevertheless, Newman is not justified in concluding that self-concept has no causal influence on subsequent academic achievement on the basis of his study.

Causal Effects of Academic Self-concept on Academic Achievement: A Reanalysis of Newman (1984)

Academic achievement is moderately correlated with general self-concept, more substantially correlated with academic self-concept, and most highly correlated with academic self-concept in the same academic content area (e.g., Byrne, 1984; Marsh, 1986; Shavelson & Bolus, 1982). This pattern of relations supports the construct validity of a multidimensional self-concept. Byrne noted that much of the interest in this relation stems from the belief that academic self-concept has motivational properties such that changes in it will lead to changes in subsequent academic achievement. She cited three prerequisites for studies of this causal effect: a) a statistical relation must be demonstrated; b) a clearly established time precedence must be established in longitudinal studies; and c) a causal model must be tested. However, Byrne found few studies that met her criteria.

Shavelson and Bolus (1982) found support for the causal influence of math, English and science self-concepts on subsequent school performance in these three areas. In contrast, Newman (1984) found no causal influence of math self-concept on subsequent math achievement. Both studies met Byrne's criteria and used LISREL analyses but differed in that: a) the first used multi-item indicators of self-concept and single-item indicators of achievement, whereas the second used single-item indicators of self-concept and multi-item indicators of achievement; b) the first considered only one time span of five months, whereas the second considered two time spans totaling eight years; and c) the first considered school grades whereas the second considered performance on standardized achievement tests. The focus of the present investigation is on problems associated with Newman's use of single-item indicators of self-concept, though similar problems may exist with Shavelson and Bolus's use of single-item factors to represent achievement.

Newman considered three sets of analyses. First, he tested his a priori model and modified it -- deleting nonsignificant paths and adding correlated residuals -- on the basis of empirical results. In this set of analyses, the reliability of each single-item self-concept factor was fixed at a plausible value since it could not be empirically determined, whereas reliabilities of the multiple-indicator achievement factors were empirically estimated. Because relations among latent constructs are corrected for unreliability in LISREL analyses, this is a critical issue. In this first set of analyses Newman demonstrated that paths leading from self-

concept to subsequent achievement were close to zero and they were eliminated from further consideration. Second, additional models positing reciprocal causal relations between self-concept and achievement at a same point in time were tested. Third, in a "sensitivity analysis," the reliabilities of the single-item self-concept factors were fixed at each of a range of reasonable values for Newman's final model to determine the generality of his findings.

I agree with Newman's contention that setting the reliability estimates of single-item factors to plausible nonzero values "made the best of a bad situation" (p. 868) and that testing a range of plausible values should provide valuable information. However, I do not agree with Newman's decision to consider in his sensitivity analysis only models in which the paths from self-concept to subsequent achievement were eliminated. Instead, I examined reliability estimates in the range considered by Newman for his original a priori model [1]. These analyses were based on Newman's published correlation matrix (1984, p.861; see the original study for a more complete description of the methods, analyses and results). Newman found that the path from Year 2 self-concept to Year 5 achievement was virtually zero for the reliabilities that he originally selected (see Table 1). However, gradually reducing the reliability estimate of Year 2 self-concept produces an increasingly stronger causal effect of Year 2 self-concept on Year 5 achievement that reaches statistical significance within the range of values considered by Newman (see Table 1). This finding, that self-concept does have a significant effect on subsequent achievement depending on the reliability estimate affixed to it, is the most important conclusion of this reanalysis.

The different reliability estimates had little effect on the overall X^2 test of fit. Since the X^2s, though reasonable, are statistically significant, additional modifications were examined. First, for Year 10 only, computation and problem solving were each measured by two tests, and allowing the error/uniquenesses associated with each pair to be correlated (Figure 1; also see footnote 1) resulted in a modest but significant improvement in fit. Second, as noted by Newman, self-concept and achievement in Year 10 were more highly correlated than could be explained by the original model. Three different approaches all resulted in the same nonsignificant X^2 value: a) positing the residuals to be correlated (as in Newman's Figure 2); b) positing each to casually effect the other but constraining the size of these reciprocal causal effects to be equal (as in Newman's Figure 3); and c) positing self-concept to have a causal

influence on achievement (see Figure 1). (A fourth model positing the causal effect of achievement on self-concept resulted failed to converge.)

The models in Figure 1 suggest two patterns of causal influence. In the Year 2 to Year 5 span: Year 2 self-concept causally influences Year 5 achievement; Year 2 achievement does not affect Year 5 self-concept (except, perhaps, through its correlation with Year 2 self-concept); and the correlation between Year 5 measures of achievement and self-concept can be explained in terms of their dependence on earlier measures. In the Year 5 to Year 10 span: Year 5 self-concept has no causal influence on subsequent achievement; Year 5 achievement has a causal influence on subsequent self-concept; Year 10 self-concept -- perhaps determined by influences other than Year 5 indicators -- has a causal influence on Year 10 achievement.

Two potential problems are apparent in these models. First, the reliability of the Year 2 self-concept ($.314 = .56^2$) is very low. However, the application of the Spearman Brown equation suggests that a multi-item scale of nine such items would have a coefficient alpha of about .8 and this may be reasonable for Year 2 students. Also, a factor loading of .56 is typically considered reasonable. Second, the stability of self-concept during the Year 2 to Year 5 span seems unreasonably high. However, this parameter estimate may be inflated by method effects often found with the repeated use of the same variable longitudinal analyses (a slightly different item was used in Year 10). In the models in Figure 1 this would be represented by a correlation between the error/uniquenesses associated with math achievement in Years 2 and 5. Without multi-item measures this possibility cannot be tested. Hence, despite these potential problems, the assumptions appear to be plausible.

In conclusion models based on the same data posited here and by Newman lead to dramatically different conclusions, depending on the values assigned as the reliabilities of the single-item factors. I do not argue that my models are superior to Newman's models; both appear to be plausible and there is no compelling basis for choosing either. However, the juxtaposition of the two demonstrates the danger of basing interpretations on single-item factors. For this reason I do not consider Newman is justified in concluding that self-concept has no causal influence on subsequent academic achievement on the basis of his study any more than I am justified in drawing the opposite conclusion. The present reanalysis indicates why it is necessary for such studies to have at least two, and preferably three or more, indicators of each latent construct.

Footnotes

1 The original a priori model posited by Newman (1984) was based on only 9 variables because he averaged the two indicators of mathematical computation and the two indicators of mathematical problem solving for Year 10 students. However, his published correlation matrix was based on all 11 variables and did not include the averaged variables he actually used. The use of 4 multiple indicators instead of 2 to infer Year 10 achievement is probably preferable, but makes little if any difference in the other parameter estimates. Positing the error/uniquinesses of the two computation measures and the two problem solving scores to be correlated (see Figure 1) may be more consistent with Newman's approach and resulted in a modest improvement in fit.

REFERENCES

Byrne, B. M. (1984). The general/academic self-concept nomological network: A review of construct validation research. Review of Educational Research, 54, 427-456.

Marsh, H. W. (1986). Verbal and math self-concepts: An internal/external frame of reference model. American Educational Research Journal, 23, 129-149.

Newman, R. S. (1984). Achoievement and self-evaluations in mathematics. Journal of Educational Psychology, 76, 857-873.

Shavelson, & Bolus, R. (1982). Self-concept: The interplay of theory and methods. Journal of Educational Psychology, 74, 3-17.

Table 1

Standardized Parameter Estimates For Newman's Original A Priori Model With Different Fixed Factor Loadings

Fixed Loadings	Parameter Estimates								
λ_3 λ_6 λ_{11}	r12	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
80 80 90	39***	95***	52***	-02	38***	86***	35***	10	26*
70 70 80	42***	93***	52***	02	51***	84***	35*	12	32
60 60 70[a]	53***	78***	23	22*	113***	98***	75***	-05	-07
55 55 65[a]	59***	75***	02	25**	148***	94***	102***	-01	-17
60 80 90	51***	81***	18	19**	82***	89***	37***	06	23
60 75 80	52***	80***	18	20**	88***	89***	40***	06	27
58 80 90	54***	79***	11	21*	90***	89***	37***	06	23
57 80 90	56***	78***	07	21*	94***	90***	37***	05	23
57 75 90	56***	78***	07	22*	100***	89***	36**	06	23
56 80 90	57***	77***	04	22**	97***	90***	38**	05	22
56 80 80	57***	77***	04	22**	97***	90***	42**	05	25
56 70 90[a]	58***	76***	00	24**	110***	90*	37**	05	21
55 70 90[a]	58***	77***	00	23**	101***	89***	38**	05	22
50 60 60[a]	66***	72***	-35	26**	168***	93***	70**	01	-01

Note. The parameters refer to those illustrated in Figure 1. The first four sets of fixed loadings, presented without decimal points, were those reported by Newman (1984) in his sensitivity analysis of a different model. For all models X^2 (38) varied between 61 and 65, but the four largest X^2 were for the first four that were used by Newman.

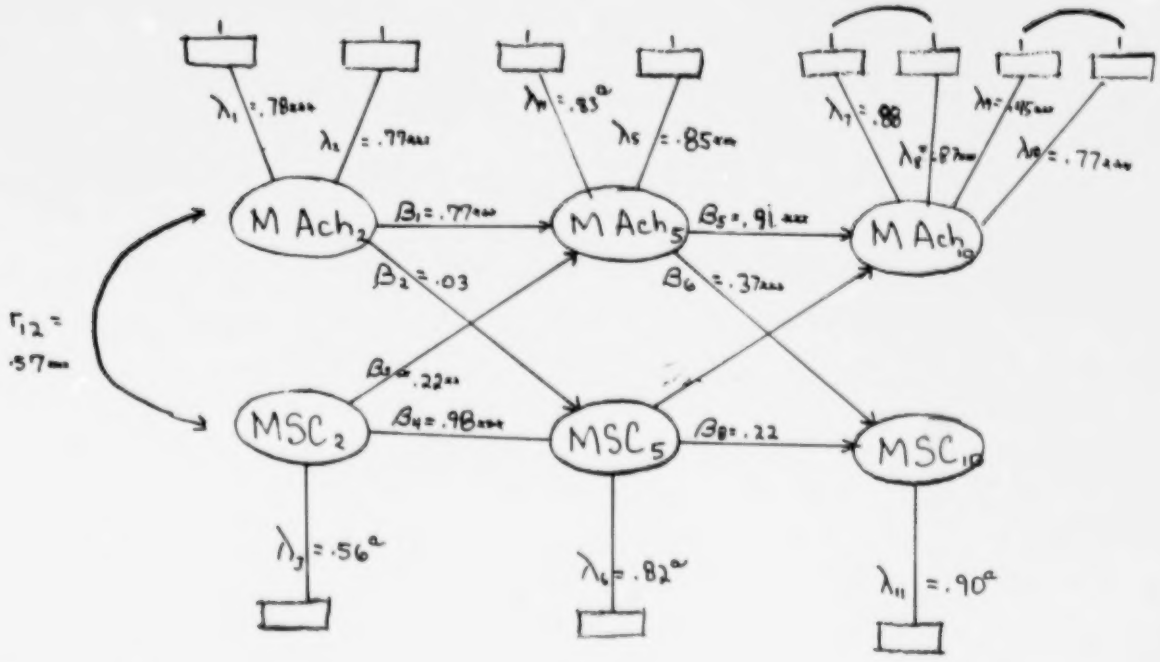
* $p < .10$; ** $p < .05$; *** $p < .01$

[a] Each of these solutions were improper in that the residual variance terms for Year 5 self-concept -- variance that is unexplained by other variables -- was negative. In none of these instances did the estimate differ significantly from zero. In fact, with the exception of the first set of loadings, the this residual variance term never differed significantly from zero.

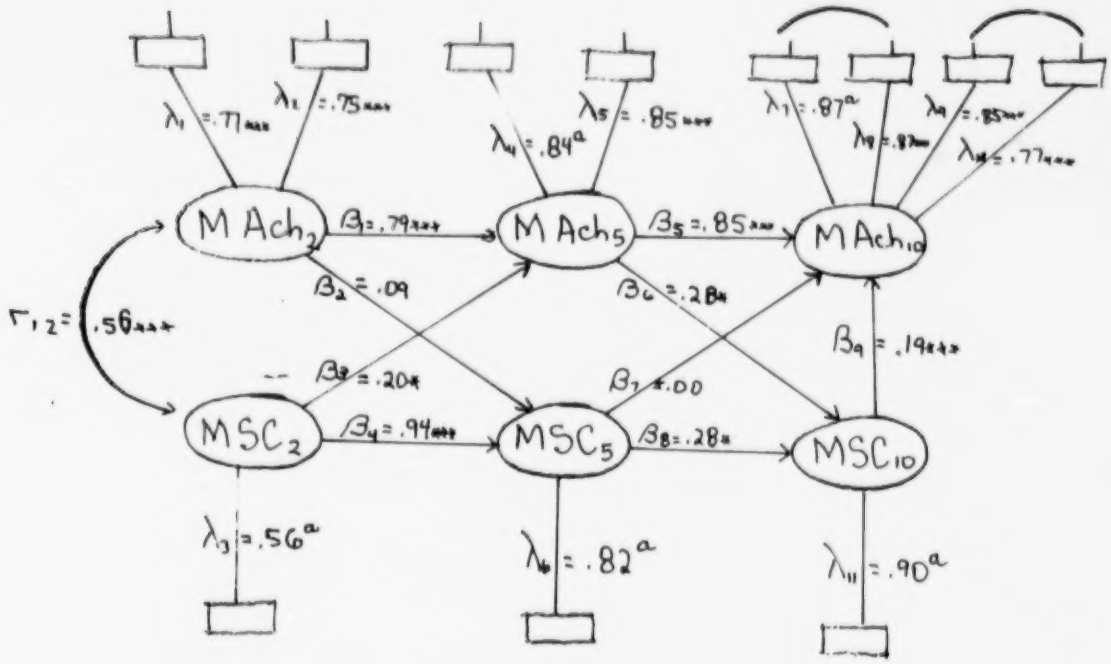
Figure 1. Standardized relations between math achievement (MACH) and math self-concept (MSC) for two models (λs = factor loadings relating latent variables to observed constructs; β s are structural parameters relating latent construct (i.e., path coefficients); r12 is a correlation between two latent variables).

* $p < .10$; ** $p < .05$; *** $p < .01$.

[a] unstandardized factor loadings were fixed to be 1.0 for the first variable used to define MACH for Years 5 and 10, and to be .56, .80 and .90 for MSC at Years 2, 5 and 10 respectively.



MODEL 1: $\chi^2(36) = 51.48$, $p = .046$



MODEL 2: $\chi^2(35) = 43.15$, $p = .162$